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RESEARCH ARTICLE

New observations on two umbraculid molluscs: *Tylodina perversa* (Umbraculida: Tylodinidae) and *Umbraculum umbraculum* (Umbraculida, Umbraculidae) along the central-eastern coast of Sicily

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Abstract

The present note aims to provide detailed information on the biology and ecology of two marine heterobranch species belonging to the order Umbraculida: *Umbraculum umbraculum* and *Tylodina perversa*. The observations were carried out through scuba dives from 2017 to May 2022 in 5 sites located along the central-eastern coast of Sicily. For each species, information on the morphology, abundance, bathymetric range, substrates and habitats, seasonality, and further remarks were here provided. Through this research, it was noted that along the central-eastern coast of Sicily, *T. perversa* has never been found on sponges of the genus *Aplysina*, its prey so far documented, but always on algal substrates. Regarding *U. umbraculum*, it was observed that it counts among the sponges of its diet also the poriferan *C. crambe*. Moreover, through this study, it was documented for the first time the breeding activity of *U. umbraculum*, never reported in detail.

Keywords

Gastropoda, Marine heterobranchs, Mollusca, Opisthobranchia, Sicily, Umbraculida.

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PENSOFT

Introduction

The group Umbraculida is a small order of marine heterobranchs, which includes about ten species worldwide distributed (Trainito and Doneddu 2014). Their external morphology is mainly characterized by the possession of an external patelliform or calyptraeiform shell (Schmekel 1985; Trainito and Doneddu 2014). In the Mediterranean, there are five species belonging to this order (Romani 2014; Fernández-Vilert et al. 2020). In particular, of these latter, the unique species present along the central-eastern coast of Sicily are *T. perversa* and *U. umbraculum* (Lombardo and Marletta 2020). Regarding this latter area, the information concerning the biology and ecology of these two species is still scarce and fragmentary. Indeed, in this area, the most recent data on these animals refer exclusively to their presence or absence and their bathymetric ranges (Lombardo and Marletta 2020). Consequently, this note aims to provide more detailed information on these species, to integrate and update the previous data, through new observations carried out in the last years. Overall, the ensemble of the past and current data could create a knowledge baseline on these marine heterobranch species, which will allow in the future to make comparisons in several areas.

Materials and methods

The present note was compiled through observations carried out from 2017 to May 2022 in 5 sites located along the central-eastern coast of Sicily (Fig. 1A–F): Ognina (37°31'50.4" N; 15°07'10.8" E) and Bellatrix (37°32'03.2" N; 15°07'35.2" E), sited within the municipality of Catania, and for proximity denoted in this study as "Catania"; Scalo Pennisi (37°38'23.2" N; 15°11'04.6" E) and Acque fredde (37°38'15.7" N; 15°10'52.1" E) located in the hamlet of Santa Tecla, in the municipality of Acireale, which for their closeness, were considered here as a unique site called "Santa Tecla"; and finally "Santa Maria La Scala" (37°36'46.5" N; 15°10'31.4" E), located between Catania and Santa Tecla, in the municipality of Acireale. Overall, a total of 395 scuba dives (152 in Catania, 119 in Santa Maria La Scala and 124 in Santa Tecla) was conducted. The dives were performed at least twice a week (marine-weather conditions allowing) between 9:00 and 11:30 a.m. Throughout the scuba dives, for each site, the same underwater path was always followed, between 0 and 45 m of depth (according to the seabed geomorphology), during which all the encountered umbraculid specimens were photographed with an underwater camera Olympus TG-4. Subsequently, the photos were analyzed to collect data on the found specimens, depth, substrate, period of the year and further observations. For each species included in this study, the following information is provided: Morphology, Abundance, Bathymetric range, Substrates and habitats, Seasonality, and Remarks.

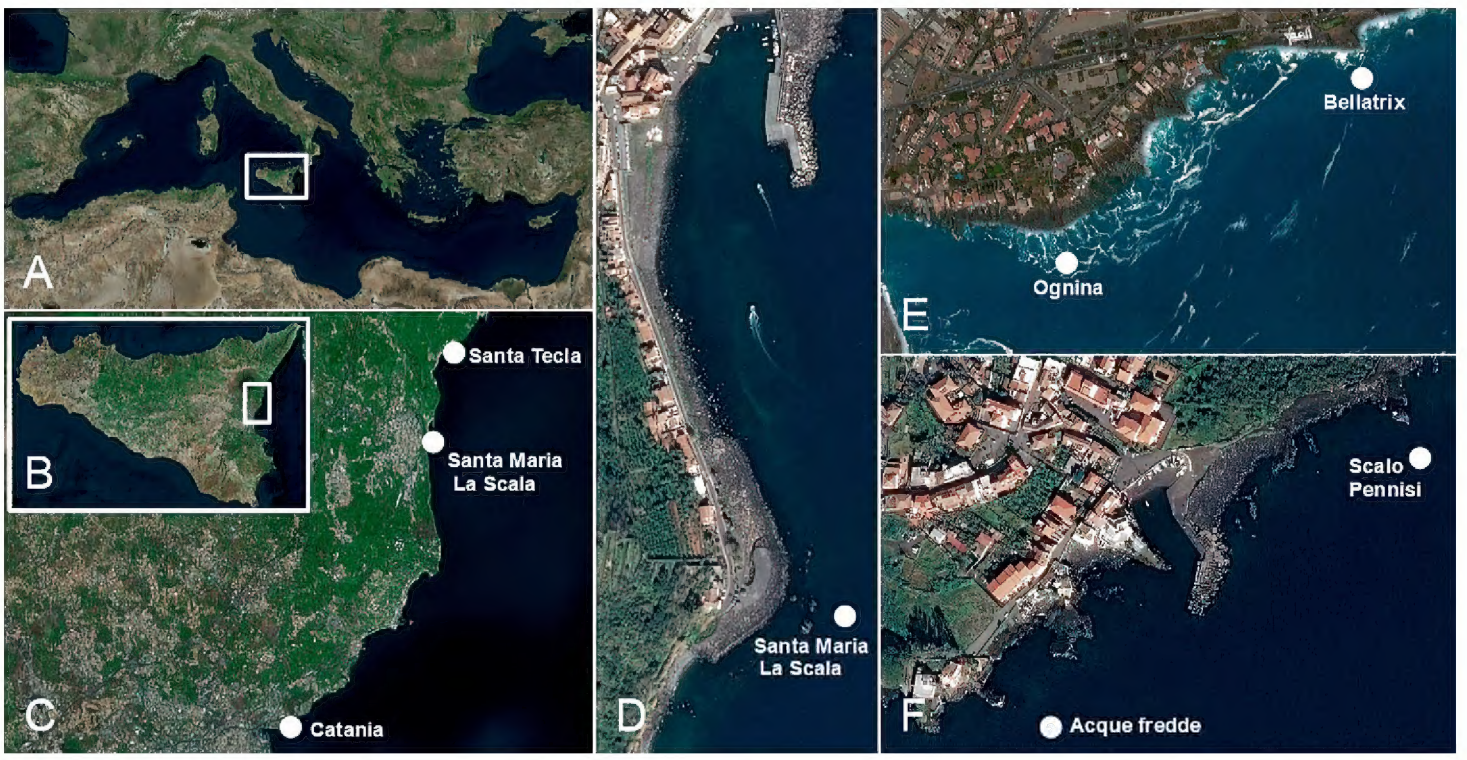

Figure 1. A Mediterranean sea; **B** Sicily; **C** Central-eastern coast of Sicily; **D** Santa Maria La Scala; **E** The two sites located in Catania: Ognina and Bellatrix; **F** The two sites located in Santa Tecla: Acque fredde and Scalo Pennisi. Map data 2022 © Microsoft Bing.

Results

Ordo Umbraculida

Family Tylodinidae Gray, 1847

Genus *Tylodina* Rafinesque, 1814

Tylodina perversa (Gmelin, 1791)

Morphology: (from 8 to 15 mm in length) this species presents a characteristic lemon-yellow body coloration (rarely very light, almost whitish). Some areas of the tegument (as the ocular areas and the ones lateral to the head and the body) can lack pigmentation, assuming a transparent-greyish colouration. The limpet-like shell, transparent and with various black-brown stripes/blotches radially disposed, possess a very evident protoconch. The rhinophores are highly developed and usually are strongly extended upwards and forwards. The oral tentacles, smaller than the rhinophores, have collectively a W shape. Under the oral tentacles, the anterior portion of the foot bends upwards, forming a characteristic fold. The attachment of the mantle to the shell is easily observable both dorsally (through the transparency of the shell) and ventrally. Between the shell and the right flank of the body, it can be noted the evident yellow gill.

Abundance: throughout this study, 16 specimens of *T. perversa* were observed: 6 in Santa Maria La Scala, 6 in Santa Tecla, and 4 in Catania.

Bathymetric range: this species was documented from 6.3 to 31.1 m of depth at Santa Maria La Scala, from 7.3 to 26 m at Santa Tecla, and from 14.2 to 37 m of depth at Catania.

Substrates and habitats: *T. perversa* was observed on the following substrates: calcareous red algae (bare or with detritus and serpulids); *Halopteris filicina* (Grateloup) Kützing and detritus; *Peyssonellia* spp.; among tangles of filamentous red algae, *H. filicina*, *Ceramium* sp., *H. scoparia* (Linnaeus) Sauvageau, *Dictyota implexa* (Desfontaines) J. V. Lamouroux; on turf of filamentous algae; *D. dichotoma* (Hudson) J. V. Lamouroux; among entanglement of *Jania* sp. with filamentous red algae and detritus.

Seasonality: Most of the observations of this species occurred between spring and summer (Table 1).

Remarks: Almost all the observed specimens of *T. perversa* were moving on or in the middle of the algal substrate on which they were found. If removed from the substrate, the animal continued crawling as usual on the authors' hands, never contracting. From an examination of the photos, it was noted that there is marked variability in the chromatic pattern of the shell's black-brown radial stripes (Fig. 2A–I). Indeed, either specimen with an evident pattern of stripes and with a faint one were observed. Furthermore, it was noted that the animal can possess or not a striking red spot located below the protoconch (probably of endogenous origin, thus, visible for transparency of the shell). Moreover, it was noted in two specimens that the surface of the shell can trap a few particles of debris or be colonized by some hydrozoan. However usually, the surface of the shell was completely free. Two specimens were found with the body pressed against the substrate: one had almost all the body retracted beneath the shell, while the other had the foot extended, but it did not show the body contracted below the shell, keeping his head out of it.

Family Umbraculidae Dall, 1889 (1827)

Genus *Umbraculum* Schumacher, 1817

Umbraculum umbraculum (Lightfoot, 1786)

Morphology: (from 40–50 mm to almost 190 mm in length) the body coloration of this animal can be variable. Indeed, throughout this study, specimens of various colorations (white-grey, yellow, orange, and brown) were encountered. The body is characterized by the presence of a large foot, whose entire surface is scattered by numerous postulose tubercles (Fig. 3A). Generally, they are greyish and are covered by shapes variably colored, according to the principal coloration of the body. The sole of the foot is smooth, and anteriorly presents the opening of the mouth. The foot has a longitudinal anterior groove above which there is the head. The latter is easily

Table 1. Findings of the two umbraculids along the central-eastern coast of Sicily: The number (coloured in green for *T. perversa* and in red for *U. umbraculum*) indicates the quantity of specimens found in that month, while "X" represents the months of 2022 not included in this note.

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
S. Maria												
2017				1		1	1	1				2
2018	1				1			1		1		
2019	2				1	1		1				
2020		1			1/1			1				
2021												
2022	1					X	X	X	X	X	X	X
S. Tecla												
2017									1			
2018	1	1								1		
2019						1						
2020	1					1	1					
2021			1		1							
2022	1				1	X	X	X	X	X	X	X
Catania												
2017												
2018												
2019							1		1			
2020							1		1			
2021												
2022	1		2	X	X	X	X	X	X	X	X	X

recognizable by the presence of the rhinophores and the characteristic eyes at their base. At the base of the external part of rhinophores there are peculiar ear-shape formations. The shell, located dorsally, can present or not a thick periostracum or be almost completely smooth. On its surface, thanks to the periostracum that traps sand and detritus, a variety of animal and vegetal organisms can develop, even luxuriantly. Ventrally to the shell, when the animal is strongly contracted, the serrated-tentacled mantle's edges are easily observable. Posteriorly on the right, in the space between the shell and the body, there is a large gill, always of the same color as the animal's body.

Abundance: during this study, a total of 23 individuals of *U. umbraculum* was found in the examined areas: 14 in Santa Maria La Scala, 6 in Santa Tecla and 3 in Catania.

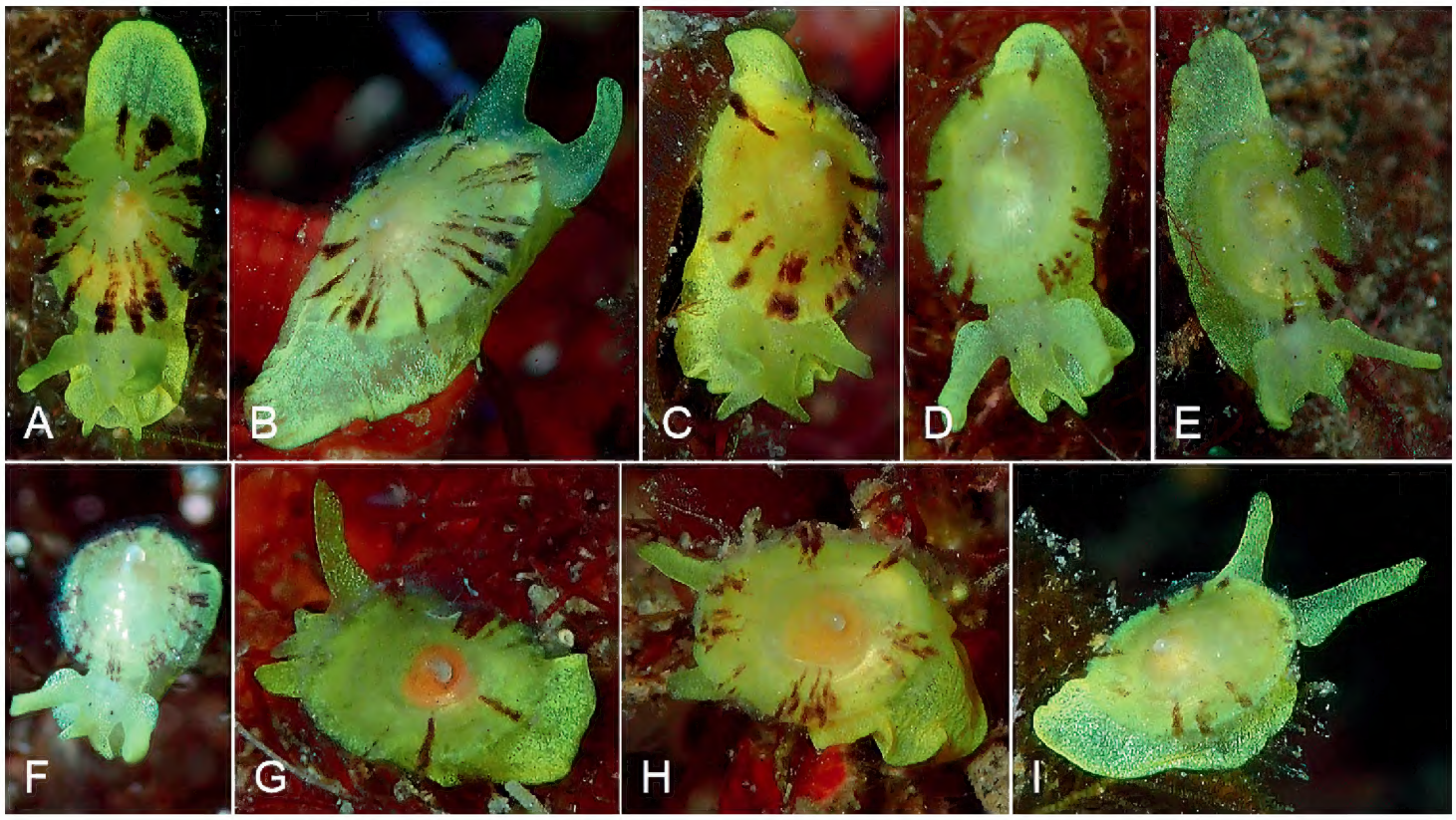

Figure 2. A-I Shell's radial pattern of different specimens of *T. perversa* (photos A. Lombardo).

Bathymetric range: the specimens were documented in the sites of Santa Maria La Scala from 13 to 36 m of depth, from 5.1 to 23 at Santa Tecla and from 6.4 to 14 m of depth at Catania.

Substrates and habitats: *U. umbraculum* was found on various substrates: red calcareous algae with detritus or not; *Peyssonnelia* spp.; turf of *Jania* sp.; *Sebdenia monardiana* (Montagne) Berthold; turf of filamentous red and brown algae; *H. filicina*; *H. scoparia*; *D. dichotoma*; *Zonaria tournefortii* (J. V. Lamouroux) Montagne; *Palmophyllum crassum* (Naccari) Rabenhorst and the sponge *Crambe crambe* (Schmidt, 1862). Generally, this species is characteristic of rocky sciaphilous deep walls and ravines rich in sponges, erect bryozoans and tunicates. Rarely, it can be found in open and well-lit environments.

Seasonality: This species can be found during the whole year (Table 1). The breeding activity was observed only once in May 2022 (see Remarks).

Remarks: Almost all the specimens documented during this study were encountered while lying stationary and motionless, on the substrates previously listed. These individuals rarely presented everted rhinophores, and generally, the mantle edges were slightly flattened against the foot. If disturbed, the animals strongly crushed against the substrate, tightening a lot the margins of the mantle. If removed from the substrate, these specimens remained in this position, and some bent the lateral edges of the foot downwards. If relocated on the substrate, they tended to remain in the same position (maintaining the edges of the foot folded). Only rarely, some specimens, after being handled by authors, extroverted the rhinophores outside the groove formed by the shell and the foot, revealing their normal appearance.

In almost all the observed specimens there were together with the periostracum, isolated serpulids and bryozoans encrusted on the shell. A single specimen presented on its shell a real microhabitat, consisting at the base of detritus and red calcareous algae, which were covered by *H. scoparia* and a turf of *Jania* sp. with filamentous algae (Fig. 3B).

Throughout this study, it was noted that whenever a specimen of *U. umbraculum* was lying on the sponge *C. crambe*, the latter presented noticeable lacerations (Fig. 3D). In a particular case, a sponge missed a great part of its surface, and it was even possible to note the rocky substrate beneath it (Fig. 3C).

In May 2022, two small-sized specimens of *U. umbraculum* (about 30 mm in length each), with their anterior parts in contact (Fig. 4A), were encountered at Catania, in a small well-lit crevice of the substrate at a depth of 6.4 m. One of the two specimens missed the shell, while the other one had it. However, when one of the authors applied light pressure to the edges of the shell, it totally detached. Even though the loss of the shell occurred sharply, the animal did not show any changes in the position of the body. Apparently, the detachment of the shell (which did not present parts of the columellar muscle or other organic parts attached on its ventral side), did not cause any damage to the animal. Both the animals in breeding had the rhinophores retracted between the foot and the mantle (Fig. 4A). At one point, one of the animals (that located on the left) started to divaricate the anterior longitudinal groove of the foot, from which slowly it everted the penis (Fig. 4D–E). This last was a small greyish protuberance (Fig. 4F), which slowly took the shape of a tube that

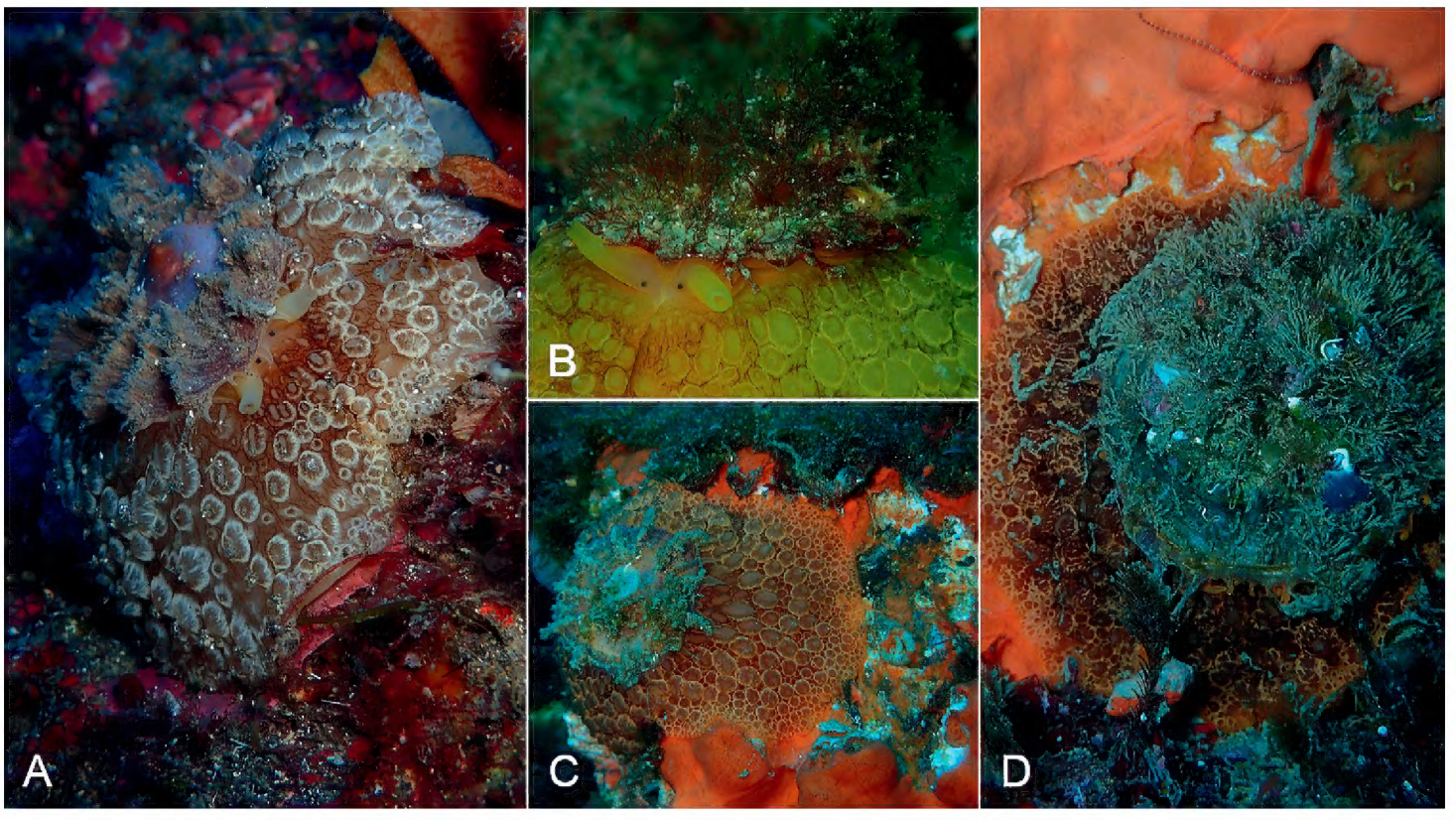

Figure 3. A Anterior view of a specimen of *U. umbraculum*; **B** the animal with the shell strongly colonized; **C** an individual which crawls away after damaging the sponge *C. crambe*; **D** another individual while damaging another *C. crambe* (photos by A. Lombardo).

was directed towards the space between the rhinophores of the other animal (the one located on the right in the Fig. 4G). Once reached this space, the penis slightly expanded also in width, becoming evident, and at the same time the receiving animal faintly extroverted the rhinophores (Fig. 4H). Then, the penis began to sag from the animal on the left (the donator animal), continuing to decrease in size towards the tip (directed to the animal on the right, the receiving animal). The distal part of the penis was the last to become inconspicuous. This stage lasted some minutes and at the end, the specimens were in the same position in which they were found (Fig. 4B).

Discussion

Through the observations presented in this note, it was possible to corroborate some hypotheses, already highlighted in the literature, but also to extend the knowledge regarding the biology and ecology of these molluscs.

Regarding *T. perversa*, none of the specimens documented in this note was found above or nearby the sponges of the genus *Aplysina* Nardo, 1834, which are instead the favorite substrate and food of this species (principally *A. aerophoba*) (Ros 1976;

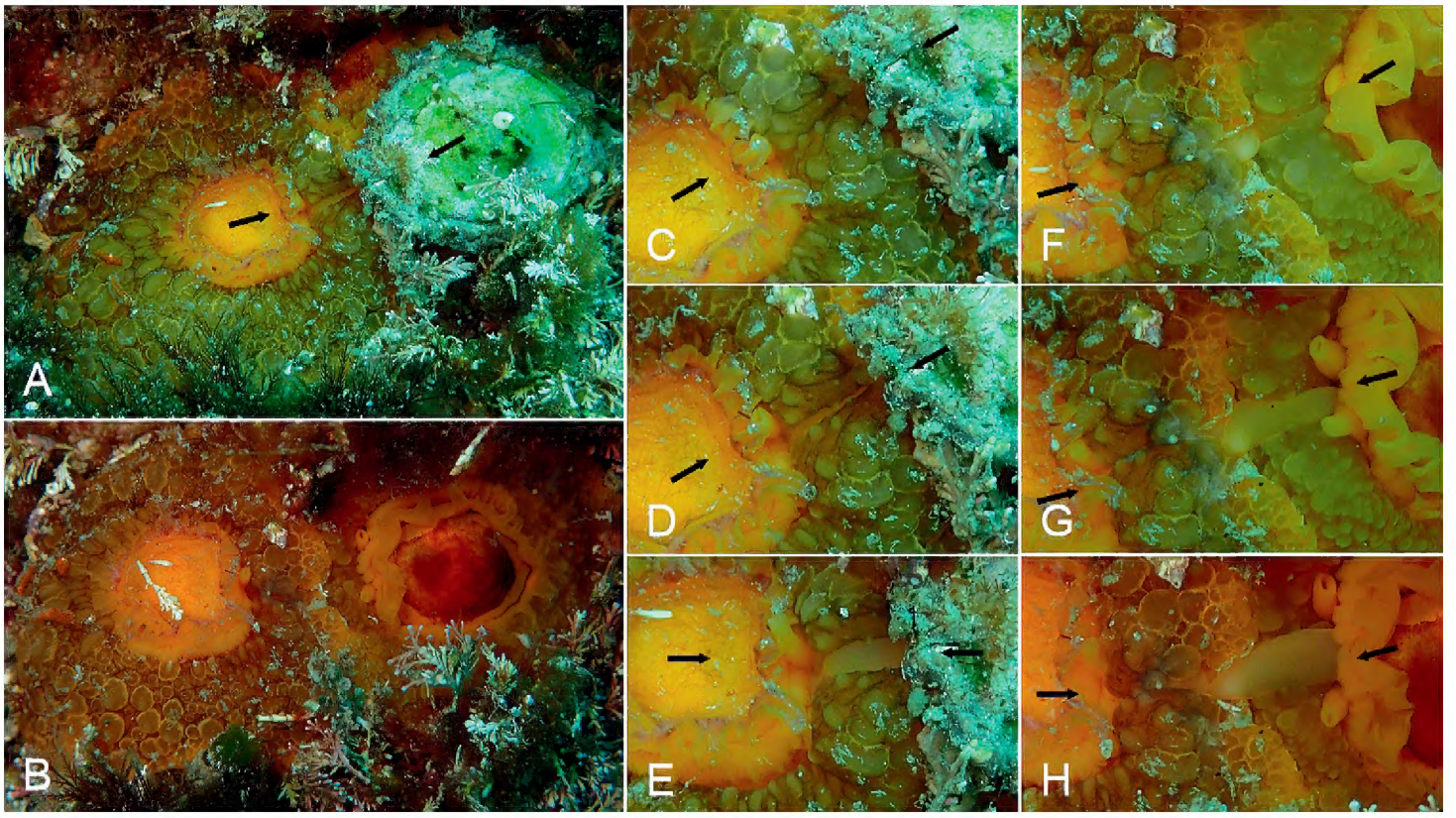

Figure 4. A Two specimens of *U. umbraculum* in breeding, one with the shell and the other without it (the arrows indicate each individual and their anterior-posterior body axes); **B** the individuals after the end of the breeding sequence; **C** the two animals at the beginning of the sequence with the rhinophores retracted between the foot and the mantle; **D-E** divarication of the anterior longitudinal groove of the foot and eversion of the left animal's penis; **F** the penis in the form of a small greyish protuberance; **G** penis extending towards the space between the rhinophores of the right animal; **H** penis dilation and its reception (photos A. Lombardo).

Valdés and Lozouet 2000; Trainito and Doneddu 2014). Along the examined area, this mollusc seems to be instead more related to algal substrates. This could reinforce the hypothesis that *T. perversa* does not feed on sponges, but rather on cyanobacteria (Becerro et al. 2003). Noting this remarkable difference in the life habits of animals that were seen to live almost exclusively in association with these sponges (Ros 1976; Doneddu and Manunza 1990; Valdés and Lozouet 2000; Becerro et al. 2003; Trainito and Doneddu 2014; Fernández-Vilert et al. 2020), and our specimens, which were never found neither nearby nor on the sponges of the genus *Aplysina*, it can be suggested that, in environments where these sponges are scarce, *T. perversa* feeds exclusively on cyanobacteria (Becerro et al. 2003). In the Mediterranean, it was reported by Trainito and Doneddu (2014) that the maximum length of *T. perversa* is 70 mm. Instead, the maximum length of the specimens observed in this study was 15 mm. Therefore, it could be assumed that the paucity of the sponges of the genus *Aplysina* along the examined areas may result in a reduction in the maximum size of the specimens of *T. perversa*. Consequently, this is reflected in the presence of "dwarf" populations along central-eastern Sicily. To confirm this hypothesis, future studies in other Mediterranean areas on this species would be necessary to allow a real comparison.

During our dives, U. *umbraculum* was often documented beneath the sponge *C. crambe*. The latter generally presented obvious lacerations and missing parts. As reported in the literature, *U. umbraculum* is a sponge predator (Willan 1984, 1998), which tends to cause considerable damage to its preys during predation (Ayling 1978; Willan 1984). Therefore, it would seem that this mollusc counts among the sponges of its diet also the poriferan *C. crambe*.

Moreover, it was possible to document thoroughly for the first time some stages of the reproduction of *U. umbraculum*. It was remarkable to note that one of the two specimens in breeding did not present yet the shell, while the other one lost it after a light pressure practiced by one of the authors on it. To our knowledge in the literature, there are no examples concerning the lack of shell (in specimens living in the natural environment). However, on the internet there are only two imagines of umbraculids without the shell, one of an individual of *U. umbraculum* (Lochore 2004) and one of an individual of *T. perversa* (Limozuin 2006). Rudman (2006) highlighted that the loss of the shell in these molluscs is not a so rare phenomenon, and probably it depends on a hypothetical predator that detached it, but the gastropod manages to survive without it. Consequently, our observation, together with those of Lochore (2004), Limouzin (2006), and Rudman (2006), show that *U. umbraculum* (but also *T. perversa*) would not seem to have an absolute need for the shell to live. To confirm this, it was remarkable to note the easiness with which the shell of one of the two individuals in breeding detached from the mantle, without causing apparently damage to the animal. This, together with the fact that the other individual did not completely possess it, could suggest that during the reproduction the participants are much more susceptible to the loss of the shell (than when they perform the other life activities) if disturbed by a predator.

In conclusion, through the present note, it was possible to gain new information on these marine heterobranch species, which jointly with those in the literature and on the internet, could favor a more in deep view and be used as starting point for future studies in other Mediterranean areas.

Acknowledgements

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